THE EFFECT OF ROCK MUSIC ON THE HEARING ABILITY OF TWO HIGH SCHOOL BOYS

by

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Running Head: The Effect of Rock Music on Hearing

The Effect of Rock Music on the Hearing Ability

of Two High School Boys

A+
very good course

Approved:

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Abstract

Two subjects each formed the experimental and control groups which were pre and post tested to determine if there is any correlation between experienced hearing loss in young people and their performing in a rock group. It appears that there is some correlation but the experiment was doubly limited and no conclusive findings can be stated with certainty.

The Effect of Rock Music on the Hearing Ability of Two High School Boys

High School students love to listen to music with a beat, with the inherent ability to move them physically, and at a loudness level that seems to transport them out of this world. The louder the piece of music can be performed the more enjoyable it seems to be for the teen-age student. Not only does the student enjoy listening and dancing to this type of music, but he receives great pleasure from performing it. Rock music is the type of music that currently embodies all the qualities necessary to appeal to this group of society. It has the rhythmic, pulsating beat, the driving force of tempo and lyrics, and is performed at a decibel level that causes one to actually feel the vibrations of each and every note.

These students want to feel every vibration. This is the essence of their enjoyment of this type of music, but it is also the cause for so many young people losing their hearing at a very early age in life. Dr. David Lipscomb, in his testimony to the EPA Office of Noise Abatement and Control reports on the "Effects of Noise on People" (1971) that in doing his research he has discovered a number of findings associated with recent trends in hearing loss. His investigations have expressed concern about

probable cause ?.

the possible adverse consequences caused by music listened to at greatly amplified sound levels. Dr. Lipscomb further indicated that young people did have hearing disorders that were attributed to exposure to music played at very intense sound levels. Dr. Lipscomb cited the following information:

> A series of audiometric tests were given to more than 7000 students in grades 6 thru 13 in 1968. The findings indicated a steady increase in hearing loss at high frequencies as measured by a 'screening test'. While 3.8% of the 6th graders failed the test more than 10% of the 9th graders failed. 30% of the in-coming freshman class failed the test. The same 'screening test' was given to the in-coming freshman class in 1969 and 61% of that class failed. This is double the percentage over the previous year.

Dr. Lipscomb says these findings give "evidence that the hearing acuity of young persons 21 years of age and under is becoming reduced many years before one would expect such reductions. These implications lead to the fearful speculation that the current population of young persons will encounter much more serious hearing problems in their middle years than the present group of 50 and 60 year olds" (p. 7).

In the Report of the Administrator of the EPA to the President and Congress on Noise (1972), the statement is made that "it has long been known that noise of sufficient intensity and duration can induce temporary or permanent hearing loss, ranging from slight impairment to nearly total deafness" (p.xxi). Rock music is not noise, especially to its' strong followers, but rock music 'is an unduly intense sound' and Zemlin (1968) states that "prolonged exposure to unduly intense sounds cause fatigue and inhibit natures' own protection system" (p.386-7).

The same Report to the President (Note 2) defines noise as "any sound - independent of loudness- that may produce an undesired physiological or psychological effect in an individual and that may interfere with the social ends of an individual or group. Those ends include all of man's activities - communication. work, rest, recreation and sleep" (p.xxi). To the devotee of rock music none of this applies, but viewed objectively, this definition can also apply to rock music. Rock music, played at the intensity level normally associated with the medium does interfere with man's activities. No man can readily communicate with another while listening to rock music. One would find it very difficult to sleep or rest while rock music is close at hand. The vibrations and driving pulsations prevent one from doing either. Rock music

is supposed to be a recreation for man, but it is more of a debilitation because of the driving force that impregnates every sound. In order to work while rock music is being played one must either adapt to the beat or completely ignore the pulse. Usually man does the latter and does not realize that all the time he is oblivious to the music it is still taking its' toll on his hearing.

The Report (Note 2) goes on to say that "in general any source of sound producing noise levels of 70dBA to 80dBA at the ear can contribute to a pattern of exposure that may produce temporary hearing threshold shifts if exposure is long enough, and this in turn could lead to permanent hearing impairment" (p. xxii). Rock music emanates at a decibel level much greater than 70dBA to 80dBA. The decibel level is closer to 110dBA to 120dBA depending on the quality of equiptment being used. If the rock group is fortunate enough to beable to afford quality amplifiers the out-put level can be greater than 120dBA.

Listening to any source of sound at such extreme levels of intensity will cause fatigue. Fatigue to the whole person as well as fatigue in the inner ear. Fatigue in the inner ear results in the temporary threshold shift (TTS). "The organ of Corti does not have a direct blood supply (Silverman, 1958). This prevents a rapid

exchange of nutrients and waste products to the cellular level during auditory stimulation. Continual stimulation depletes the energy sources of the cells and produces the TTS" (pp. 442-3). If the exposure time is short in duration the threshold shift will return to its normal state. The result will be no loss in hearing ability. There is a cumulative effect in attendance here however, and though one listens to music for short intervals of time, with a possible rest period between segments, there may not be enough of a 'rest period' to allow the threshold to return to normal. Each period of music that is heard causes more fatigue and eventually the TTS becomes a permanent threshold shift. "Permanent threshold shifts (PTS) result from noise-induced cochlear injuries" (Report, Note 2, p.10). This PTS may take years or months depending on the individual ear, the daily exposure, and the intensity of each exposure.

A great deal has been written concerning the exposure time and decibel level allowable in industry before any TTS will occur in all but the most susceptible 5% of exposed individuals. The latter individuals are said to have 'tender' ears. The presumption is made that relative quiet will exist in the ensuing time affording auditory recovery.

The EPA in the bulletin "Fundamentals of Noise" (1971) has

indicated that:

1. An 8 hr. day of continuous exposure to levels below 90dBA over a period of many years, will not produce a noise-induced hearing handicap, in 80 - 90% of the exposed population.
2. Data, mainly from studies based on TTS, indicate that halving the exposure time per day and increasing the noise level by 5dBA will not increase the hazard of hearing impairment.
3. Noise exposure composed of 2 or more periods per day becomes cumulative and the different levels combine (p. 20).

This can be seen more readily in Table No. 1. This Table is reproduced from the EPA Bulletin on the "Fundamentals of Noise", December 31, 1971 page 21.

Insert Table 1 about here

7

It is important to remember that the number of exposures to noise per day, is cumulative. The individual does not readily realize

this phenomena. He may work in a noisy environment and choose to listen to or participate in a rock group as a form of relaxation after working hours.

Whereas, in occupational exposure time 80-90% of the population is tried to be helped, in non-occupational exposure time all of the population should be helped. "This includes protection of hearing at higher frequencies" - music (EPA, Note 5, p. 21). The same Bulletin further limits the maximum suggested non-occupational exposure time as beginning at 70dBA for 16-24 hours and continuing to 115dBA for only 2 minutes. Table No. 2 shows the complete range of decibel levels and allowable exposure time. This table is reproduced from the EPA Bulletin on the "Fundamentals of Noise", December 31, 1971, page 21.

Insert Table 2 about here

The Table stops at 115dBA, but it has been previously stated that rock music can exceed decibel levels of 120dBA. If one were to carry the table on it would read 120dBA - 1 minute, 125dBA - $\frac{1}{2}$ minute and 130dBA - $\frac{1}{4}$ minute. No piece of music is that short in duration, but the decibel level can reach that amount. Moreover, noise (EPA, Note 5, 1971) can be considered dangerous to

hearing if the TTS measured 2 minutes after the exposure regularly exceeds 10dB at or below the frequency of 1000, 15dB at the frequency of 2000, or 20dB at or above the frequency of 3000. Damage may occur immediately when the TTS produced by a single exposure exceeds 40dB (p. 22). This is known as traumatic damage. The Bulletin on "Social Impact of Noise" (EPA, 1971) goes on to say a "PTS may also occur if a TTS has not disappeared within 24 hours" (p. 24).

To test a rock musician 2 minutes after he performed a composition would be very difficult. However, one can easily learn if the TTS has returned to normal within 24 hours. Rock musicians complain about a 'constant ringing in their ears at a particular pitch' for hours after a performance. This is a TTS. This is a warning signal.

The tinnitus (ringing) in the ear is an indication of damage. The ear needs rest from sound. Silverman (1961, Note 4) states the "organ is sensitive to the tell tale sound waves given off by most events around man. The organ is so delicate it may be injured by very intense blasts of sound" (pp. 32-33). The Report to the President (1972, Note 2) describes the organ this way:

> The sensory cells of hearing are the hair cells in the organ of Corti and the fibers of the auditory

> nerve. The integrity of the sensory cells and the organ of Corti is important for normal hearing. The organ of Corti is about 34 millimeters long and contains about 17,000 hair cells. The degree of hearing loss depends not only on the severity of injury at any one location but also on the spread of injury.
>
> Intense sound can produce vibrations of such severity in the organ of Corti that some of its simply torn apart.
>
> Severe exposure can cause structural damages that lead to rapid breakdown of the processes necessary for maintaining the life of the cells. Once cells are destroyed they're lost forever. They do not regenerate and cannot be stimulated to regenerate (pp. 1-6).

The earliest cellular changes in the ear are difficult to detect visually, but as the injury level increases cells become difficult to distinguish. The tunnel of Corti (Rose, 1971) becomes filled with debris, and the "nuclei of the outer hair cells begin to disappear. In time stimulation causes a disappearance of the organ of Corti, disruption in Riessner's membrane, and other destruction"

(pp. 442-442). The organ of Corti is eventually replaced by a layer of epithelial cells. The organ of Corti is the ultimate organ for perceiving sound. When the organ of Corti is replaced by epithelial cells the individual has lost the ability to hear. The four pictures reproduced from the EPA Report to the President (Note 2, p. 7) shows the various stages in the destruction of the organ of Corti.

Insert Pictures about here

Man does not realize he is losing his hearing until too much damage has occurred because noise exposure causes reduction in acuity of the higher frequencies first. Newby (1958) names the high frequency end of the basilar membrane and organ of Corti as being most susceptible to damage from intense vibration (p. 51). The region referred to corresponds to the frequencies of 3000 to 6000 cps. This range is higher than the frequency level for the understanding of speech. Therefore, man does not realize his hearing is deteriorating because he can still understand 'what is being said to him'. Newby (Note 8) also states that "it is very common to see an audiogram that shows the greatest amount of loss in the area of 4000 cps. This is known as the '4000-cycle dip' and is an indication of damage due to exposure to

noise (pp. 51-53).

The critical range to the understanding of speech lies between the frequencies of 500 and 2000. If the average loss of the frequencies 500, 1000 and 2000 dB exceeds 25dB then a slight hearing handicap is declared and man will have difficulty understanding faint speech. Man has to have an average loss of 40dB over three middle frequencies before he has difficulty with normal speech. When this happens he already has sustained very much damage to his inner ear.

All the governments of the world have set-up Agencys to limit noise pollution. All the governments have set standards for protecting the hearing of man from noise, but it remains for our young people to heed the warnings issued. The young people of the world must be made to realize the danger they are inflicting upon themselves by subjecting themselves to such intense levels of sound.

The present study attempts to show that intense sounds, in the form of rock music, has had an effect on the hearing of two 16 and 17 year old high school boys who perform with a rock band and do not wear ear protectors.

Experiment

Method

Subjects. The subjects were chosen from the music department of Dupo High School in Dupo, Illinois. Two subjects were chosen from the instrumental department because of their regular performance with rock groups. Two subjects were also chosen from the choral department to act as a control group. All four students were selected from volunteers who showed an interest in 'learning whether there was any evident change in their hearing because of their performance or interest in rock music'.

Insert Table 3 about here

None of the subjects had experienced any history of hearing problems or ear aches in childhood. The families of these subjects had not experienced any hearing problems or ear aches, either.

Group A. Group A was the experimental group. Subject #1 was a 14 year old boy who was a drummer by profession. He had been with rock groups consistently since 6th grade. He had two older brothers who were in rock groups. This afforded him the opportunity of being involved with rock groups from an early age. Subject #2 was a 15 year old boy who plays the trumpet. He, too,

had been studying the instrument since 4th grade. He had been performing with his own rock group since 7th grade. He had one older sister who played piano.

Group B. Group B was the control group. Subject #1 was a 14 year old boy who sang tenor. He enjoyed all types of music, but rock was his favorite. He listened to rock music but did not participate in rock performances as a musician. He had two older brothers in the choral department. Subject #2 was a 15 year old boy who sang bass. He enjoyed rock music but did not participate as a performer. He, too, had one older sister who played piano. Music was enjoyed by all the families and active participation in some form of music was encouraged. The subjects did not know they were part of an experiment other than having the original hearing pre-test.

Pre-test. The pre-test was administered on December 3, 1975 by this examiner. When tested, Subject #1 in Group A showed a 20dB loss in the low frequencies, a 15dB loss in the middle frequencies, and no loss in the higher frequencies in his left ear. His right ear showed a 5dB loss in the lower frequencies, a 10dB loss in the middle frequencies and no loss in the upper frequencies. Subject #2 in group A showed a 20dB loss across all frequencies bilaterally. The subjects in Group B exhibited no loss over any of the frequen-

cies. See the Audiograms that follow.

Insert Audiogram 1 about here

Materials. A Maico Audiometer, Model #5911, calibrated according to ISO standards at 25dB FDPH was used for testing.

Procedure. A case history was taken from the family of each subject to determine whether they had any congenital abnormalities, birth defects, or illnesses during any part of their life which could result in a hearing loss. The results were negative for all subjects. The school health records were checked to determine whether they all had 'passed' the hearing 'screening test' given throughout grade school. The results were positive, which indicated that based on school screenings, no hearing problems were evident from kindergarten thru grade 6. An air conduction hearing test was administered to all four subjects by the examiner. The school nurse, administered the previous grade school 'screening tests'. Two years after the pre-test, on December 3, 1977, all four subjects were re-tested by the same examiner.

Results. The results of this experiment show the hearing loss of Subject #1 in Group A had increased 5dB in the lower frequencies and 20dB in the frequencies above 2K. Subject #2 in Group A

Showed no change from his pre-test audiogram. Both Subjects in Group B showed no change in their audiograms from their pre-test. See second set of Audiograms.

Insert Audiogram 2 about here

Discussion. While both Subjects in Group A continued to perform regularly 2 to 3 nights a week on the average of 3 to 4 hours each evening there were some alterations in the experiment. Subject #2 in Group A began wearing ear protectors in 1976 without telling the examiner. He decided he could not bear ' having his ear ring at the pitch of B^{b}' for hours after he finished performing at night. The ear protectors may have kept him from receiving any further damage to his hearing. Subject #1 showed an increase in hearing loss, especially in the higher frequencies, but I wonder one if his original loss in the lower frequencies was a result of his being a drummer. If this was the original cause then it would seem that his hearing should have deteriorated still further in his lower frequencies. The loss in his higher frequencies could be the result of chance through history or maturation or a further emphasis of hearing loss due to the intense vibration of rock music performance.

A further problem which clouds this experiment is the fact that public school 'screening tests' do not register any abnormality below 25dB. While the case histories show the students had positive results on their 'screening tests', the pre-test did test the full range of frequencies and the lowest decible level of hearing was established each time. Public school 'screening tests' do not test lower than 25dB unless a negative is found at that frequency.

It does seem from the small amount of research accomplished that a correlation between 'intense sound' or rock music and hearing exists, but the results are not as overwhelming as expected.

Summary and conclusion. There seems to be damage to hearing resulting from the subjects performing with rock groups, but the evidence is not conclusive. The original study was limited and the subjects further limited the experiment by altering the situation. The study would have been better if more subjects had participated in the original experiment, if more tests had been administered, and if controls could have been used to a greater degree to lessen the possibility of chance.

References

Davis, H. , & Silverman, S. R. Hearing and Deafness. New York: Holt, Rinehart, & Winston, 1961, 32-54, 135-144.

Newby, H. A. Audiology. New York: Appleton-Century-Crofts, 1958, 51-53, 266-279.

Rose, D. E. (Ed.). Audiological Assessment. New Jersey: Prentice-Hall, Inc., 1971, 440-466.

Studebaker, G. A. Industrial and Military Audiology. New Jersey: Prentice-Hall, Inc., 1968, 423-424.

Zemlin, W. R. Speech and Hearing Science. New Jersey: Prentice-Hall, Inc., 1968, 386-387.

Source Document Information

The technical Information Documents used as the basis for the preparation of this paper were taken from the Documents of the Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D. C. 20460. They are listed below according to number.

NTID300.1 - Noise From Construction Equiptment and Operations, Building Equiptment, and Home Appliances, prepared by Bolt, Beranek and Newman under EPA contract 68-04-0047.

NTID300.2 - Noise From Industrial Plants, prepared by I. S. Goodfriend Associates under contract EPA 68-04-0044.

NTID300.3 - Community Noise, prepared by Wyle Laboratories under

EPA contract 68-04-0046.

NTID300.4 - Laws and Regulatory Schemes for Noise Abatement, prepared by the George Washington University under EPA contract 68-04-0032.

NTID300.6 - An Assessment of Noise Concern in Other Nations, prepared by Informatics, Inc, under EPA contract 68-01-0157.

NTID300.7 Effects of Noise on People, prepared by the Central Institute for the Deaf under EPA contract 68-01-0500.

NTID300-10 - Summary of Noise Programs in the Federal Government, prepared by the staff of the EPA Office of Noise Abatement and Control.

NTID300.11 - Social Impact of Noise, prepared by the National Bureau of Standards under interagency agreement with the Department of Commerce.

NTID300.15 - Fundamentals of Noise: Measurement, Rating Schemes, and Standards, prepared by the National Bureau of Standards under interagency agreement with the Department of Commerce.

Table 1

Maximum Recommended Occupation Noise Exposure

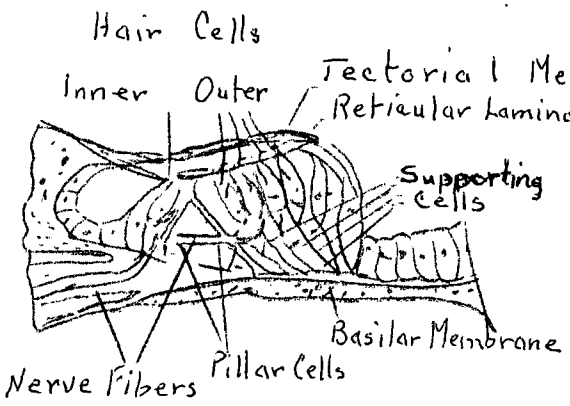
Sound Level	Daily Exposure Time
dBA	hr.
90	8
(92)	(6)
95	4
(97)	(3)
100	2
(102)	(1-1½)
105	1
110	½
115	¼ or less

Table 2

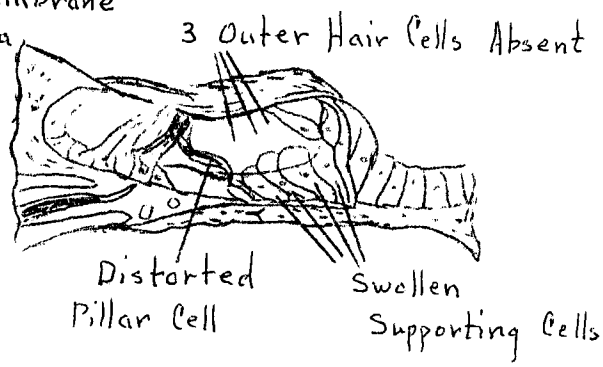
Suggested Maximum Non-Occupational Exposure Time

Sound Level	Daily Exposure Time
dBA	hr.
70	16-24hrs.
75	8
80	4
85	2
90	1
95	30 min.
100	15 min.
105	8 min.
110	4 min.
115	2 min.

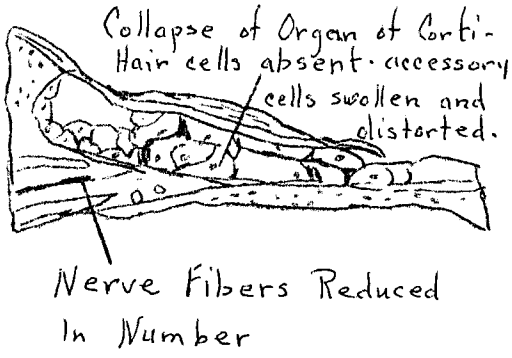
Pictures



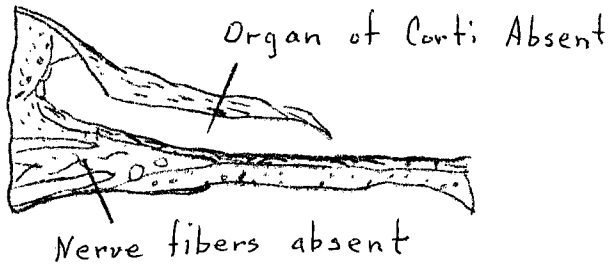
NORMAL ORGAN OF CORTI



PARTIAL INJURY



SEVERE INJURY



TOTAL DEGENERATION

Sensory Organ of the Inner Ear

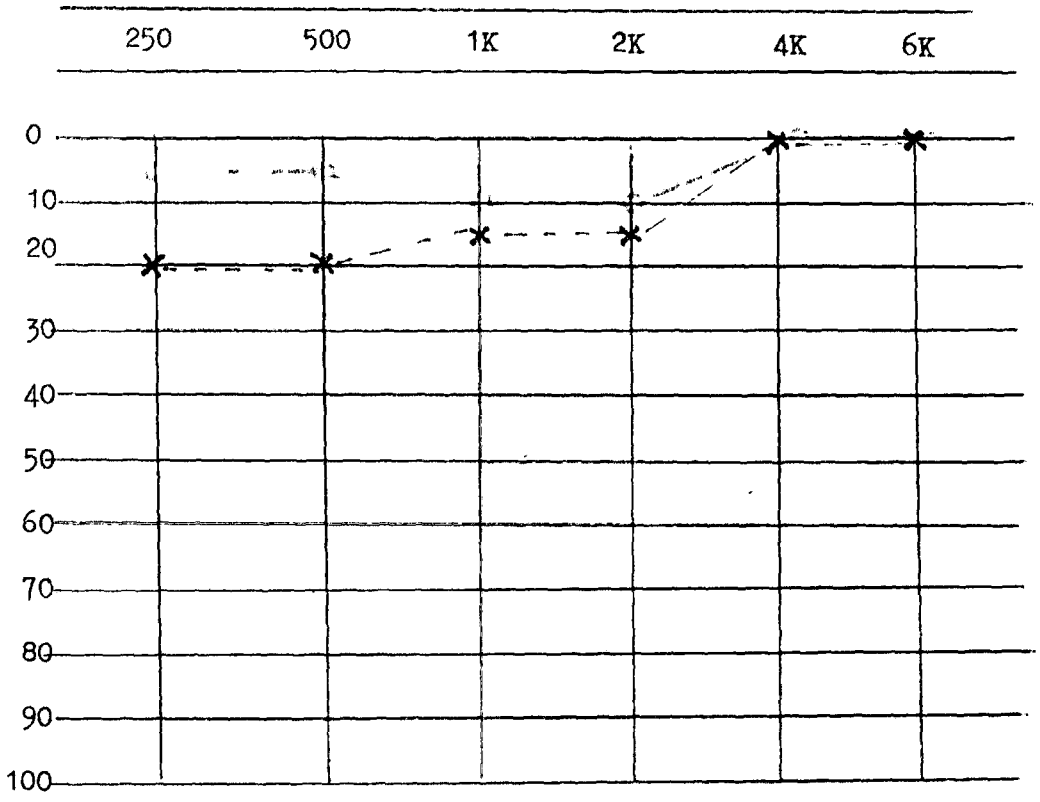
Table 3

Characteristics of Subjects

Subject	Age	Sex	Family Size	Outside Interest
Group A				
#1	14	M	5	Rock music
#2	15	M	4	Rock music
Group B				
#1	14	M	5	Rock music
#2	15	M	4	Rock music

Figure 1

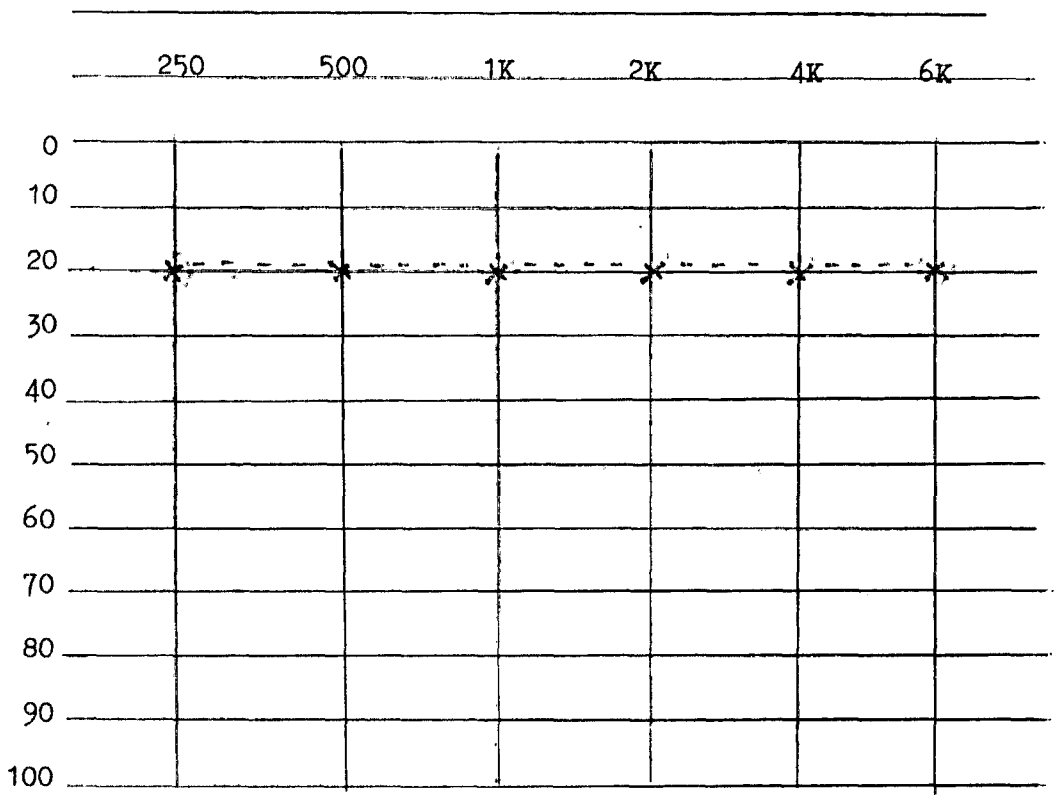
Pre-test Audiogram



Subject #[illegible] - Group A

Figure 1

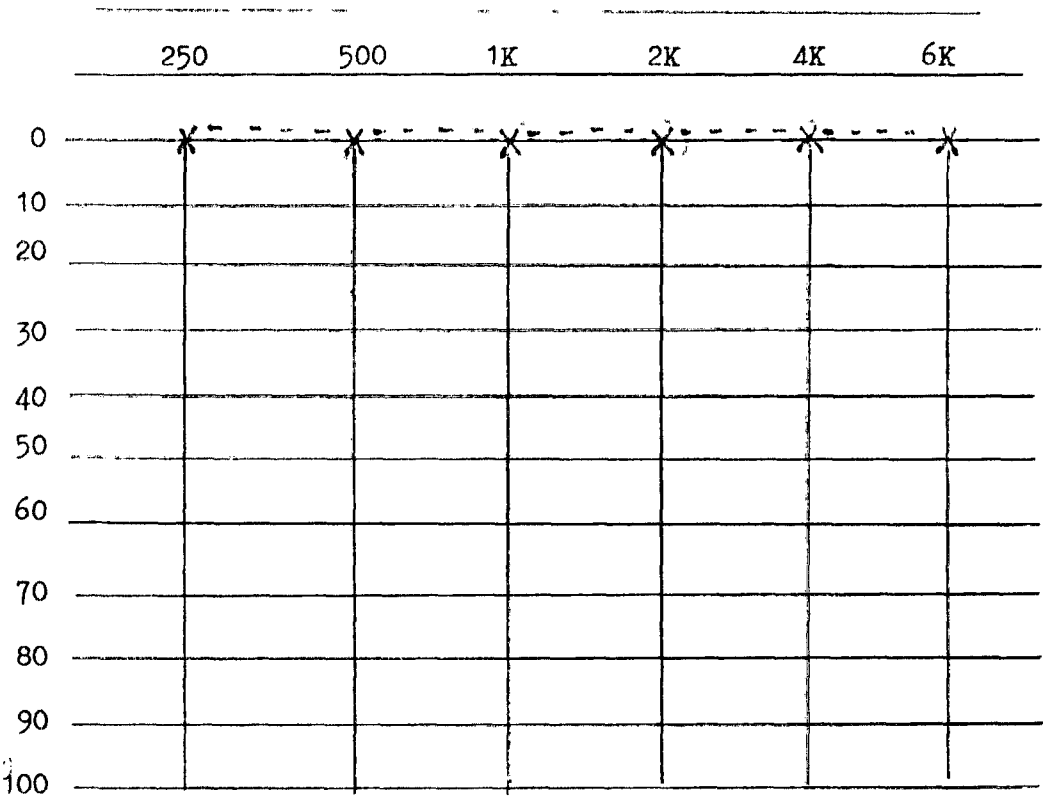
Pre-test Audiogram



Subject #2 - Group A

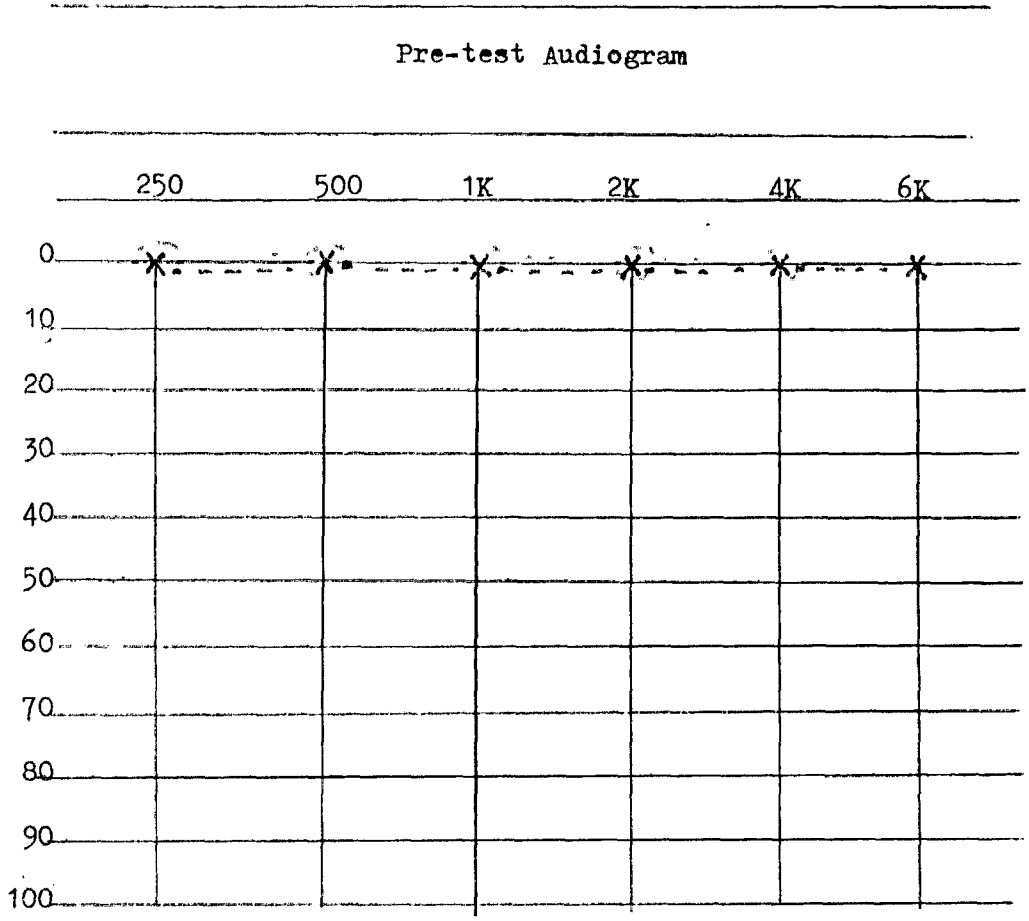
Figure 1

Pre-test Audiogram



Subject #1 - Group B

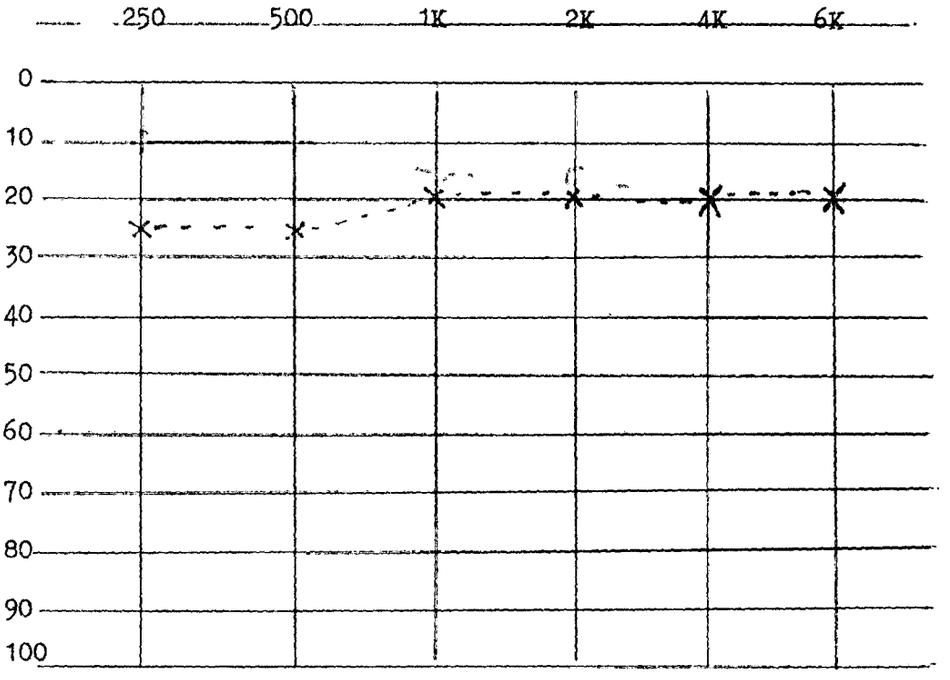
Figure 1



Subject #2 - Group B

Figure 2

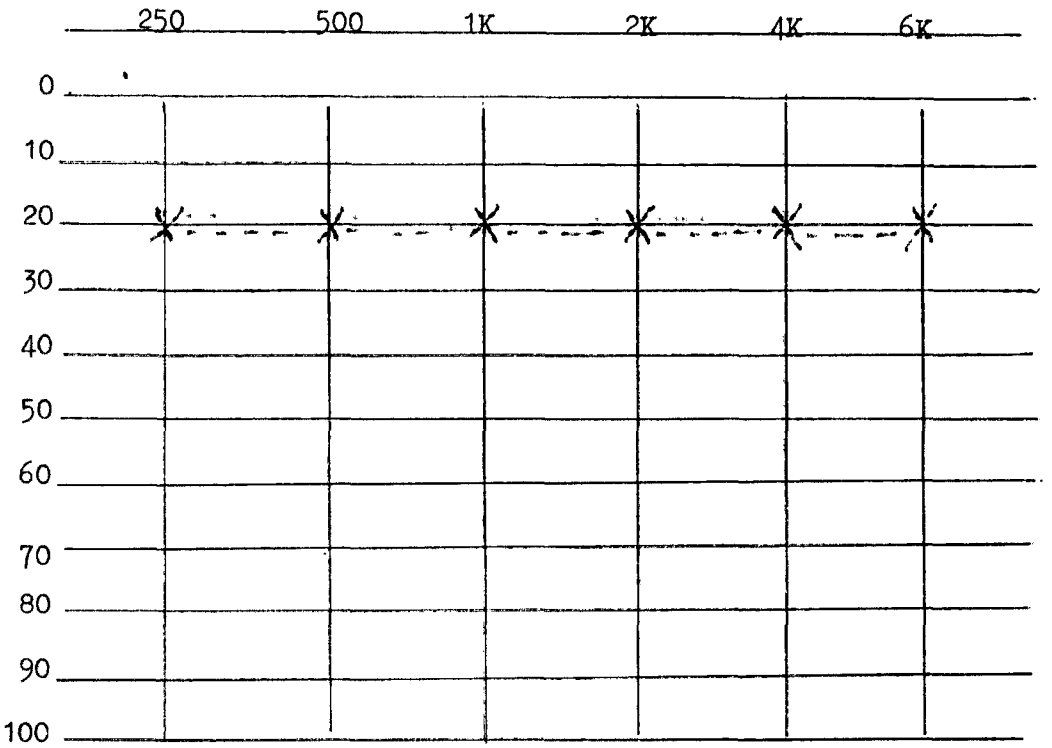
Post-test Audiogram



Subject #1 - Group A

Figure 2

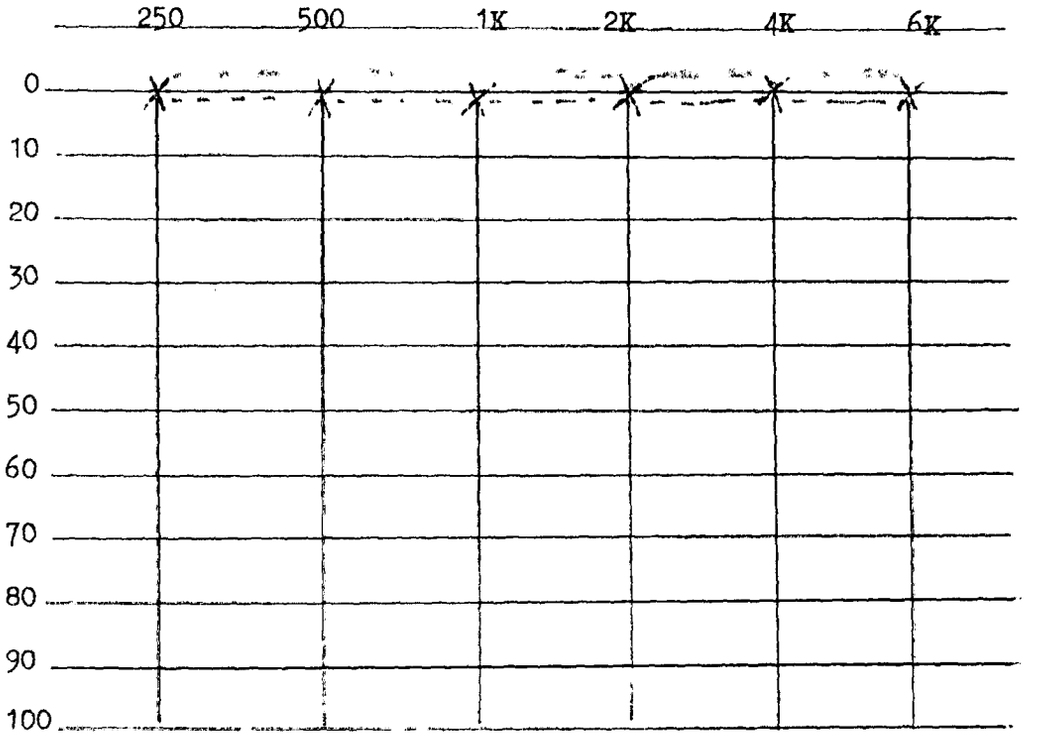
Post-test Audiogram



Subject #2 - Group A

Figure 2

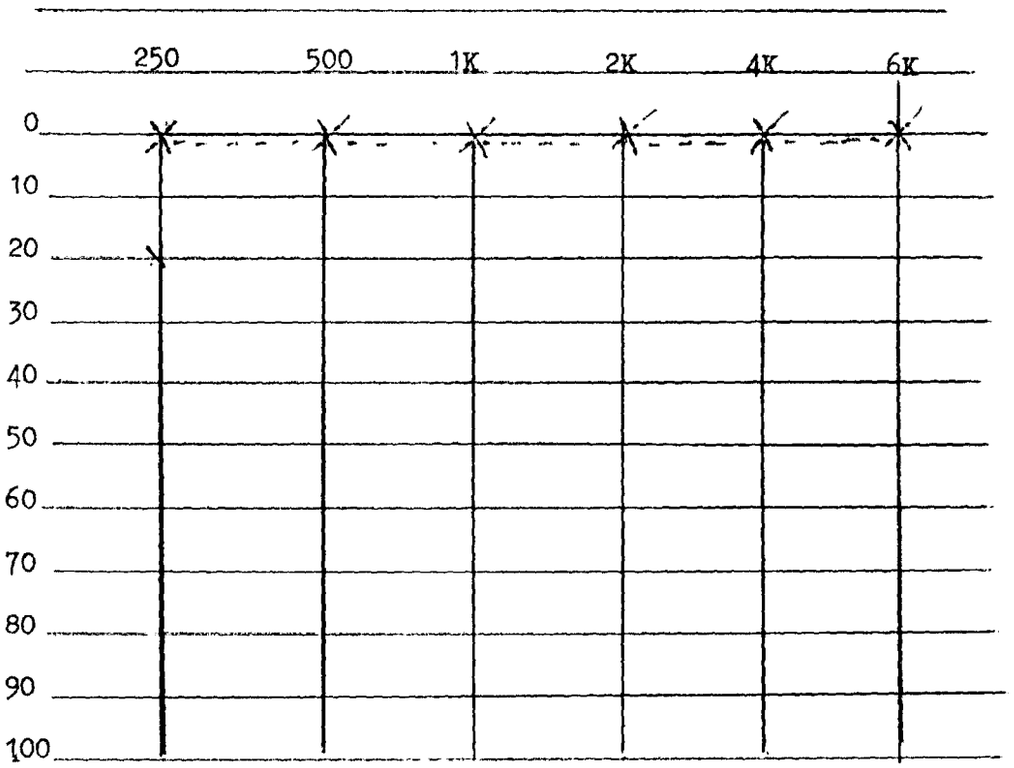
Post-test Audiogram



Subject #1 -Group B

Figure 2

Post-test Audiogram



Subject #2 - Group B